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(54) **Apparatus for tissue sealing**

Vorrichtung zum Versiegeln von Gewebe

Appareil pour l'étanchéité de tissus

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**Description****BACKGROUND***Technical Field*

[0001] The present disclosure relates to forceps for sealing various types of tissue. More particularly, the present disclosure relates to open, laparoscopic or endoscopic forceps that utilize ultrasound energy to seal tissue.

*Description of the Related Art*

[0002] In many surgical procedures, body vessels, e.g., blood vessels, ducts, adhesions, fallopian tubes, etc. are sealed to defunctionalize or close the vessel. Traditionally, staples, clips or sutures have been used to close a body vessel. However, these traditional procedures often leave foreign body material inside a patient. In an effort to reduce foreign body material left within the patient and to more effectively seal the body vessel, energy techniques that seal by heat processes have been employed.

[0003] A forceps is particularly useful for sealing tissue and vessels since forceps utilizes mechanical action to constrict, grasp, dissect and/or clamp tissue. Current vessel sealing procedures utilize heat treatment to heat and desiccate tissue causing closure and sealing of the body vessel. In addition, forceps allow for control of the applied pressure to the tissue. The combination of heating and applied pressure provides a uniform, controllable seal and that is capable of providing such a seal with minimum collateral damage to body tissue.

[0004] The patent applications EP 1 974 771 A1 and US 2003/0018270 A1 disclose forceps according to the preamble of claim 1.

**SUMMARY**

[0005] According to one aspect of the present disclosure, an ultrasound forceps for sealing tissue is provided. The forceps includes one or more shaft members having an end effector assembly disposed at a distal end thereof. The end effector assembly includes opposing jaw members movable from a first position in spaced relation relative to another subsequent position wherein the jaw members cooperate to grasp tissue therebetween. One or both of the jaw members includes an ultrasound transducer coupled to an ultrasound generator adapted to provide an electrical signal to the ultrasound transducer to induce treatment pulses therein.

[0006] Further features of the forceps of the present invention are defined in claim 1.

[0007] A method for sealing tissue is also contemplated by the present disclosure. A method is not a claimed aspect of the present invention. The method includes an initial step of providing an ultrasound forceps including

an end effector assembly having opposing jaw members. One or both of the jaw members includes an ultrasound transducer. The method also includes the step of supplying an electrical signal to the ultrasound transducer to induce vibrations therein.

[0008] Each of the jaw members may include a plurality of ultrasound transducers coupled to an ultrasound generator adapted to provide an electrical signal to the plurality of ultrasound transducers to induce treatment pulses therein. The treatment pulses induce heating and provide localized transient pressures in combination with sustained jaw pressure by the opposing jaw members to bond tissue elements and/or tissue polymer chains resulting in joining of tissue surfaces or formation of anatomical lumens.

**BRIEF DESCRIPTION OF THE DRAWINGS**

[0009] Various embodiments of the present disclosure are described herein with reference to the drawings wherein:

Fig. 1 is a perspective view of a tissue sealing system including a forceps and an energy generator according to one embodiment of the present disclosure; Fig. 2 is a cross-sectional view of a distal end of the forceps of Fig. 1;

Fig. 3 is cross-sectional side view of an ultrasound end effector assembly according to one embodiment of the present disclosure;

Fig. 4 is a perspective view of an ultrasound transducer, which is not according to the present invention;

Fig. 5 is a perspective view of an ultrasound transducer, which is not according to the present invention;

Fig. 6 is a perspective view of an ultrasound transducer according to another embodiment of the present invention;

Fig. 7 is a perspective view of an ultrasound transducer according to another embodiment of the present invention;

Fig. 8 is a top view of jaw members of the ultrasound end effector according to another embodiment of the present disclosure;

Fig. 9 is a top view of jaw members of the ultrasound end effector according to another embodiment of the present disclosure; and

Fig. 10 is cross-sectional side view of an ultrasound end effector assembly according to one embodiment of the present disclosure.

**DETAILED DESCRIPTION**

[0010] Various embodiments of the present disclosure are described hereinbelow with reference to the accompanying drawings. Wellknown functions or constructions are not described in detail to avoid obscuring the present

disclosure in unnecessary detail. Those skilled in the art will understand that the present disclosure may be adapted for use with either an endoscopic, laparoscopic or an open instrument; however, different electrical and mechanical connections and considerations apply to each particular type of instrument. The novel aspects with respect to vessel and tissue sealing are generally consistent with respect to these designs. In the drawings and in the description which follows, the term "proximal", as is traditional, will refer to the end of the forceps that is closer to the user, while the term "distal" will refer to the end of the forceps that is further from the user.

**[0011]** Referring now to Fig. 1, a tissue sealing system 2 according to the present disclosure is shown including a forceps 10 coupled to a generator 20. The forceps 10 is adapted to seal tissue using ultrasound energy. The generator 20 is configured to output an electrical excitation signal to one or more ultrasound transducers within the forceps 10 at a frequency greater than 5 MHz. The forceps 10 is coupled to the generator 20 via a cable 1 adapted to transmit the appropriate energy and control signals therebetween. Various embodiments of the forceps 10 utilizing the aforementioned types of energy are discussed in more detail below.

**[0012]** The forceps 10 is configured to support an end effector assembly 100. Forceps 10 typically includes various conventional features (e.g., a housing 60, a handle assembly 75, a rotating assembly 80, a trigger assembly 70) that enable forceps 10 and end effector assembly 100 to mutually cooperate to grasp, seal and, if warranted, divide tissue. Forceps 10 generally includes housing 60 and handle assembly 75, which includes moveable handle 62 and handle 72 that is integral with housing 60. Handle 62 is moveable relative to handle 72 to actuate end effector assembly 100 to grasp and treat tissue. Forceps 10 also includes shaft 12 that has distal end 14 that mechanically engages end effector assembly 100 and proximal end 16 that mechanically engages housing 60 proximate rotating assembly 80 disposed at the distal end of housing 60. Rotating assembly 80 is mechanically associated with shaft 12. Movement of rotating assembly 80 imparts similar rotational movement to shaft 12 which, in turn, rotates end effector assembly 100. The shaft 12 may be either rigid or flexible. In one embodiment the end effector assembly 100 may be articulated with respect to the shaft 12. In another embodiment, the end effector assembly 100 may be disposed at a distal end of a catheter.

**[0013]** End effector assembly 100 includes two jaw members 110 and 120 having proximal ends 111, 121 and distal ends 113, 123. Jaw members 110 and 120 are pivotable about a post 160 and are movable from a first position wherein jaw members 110 and 120 are spaced relative to another, to a second position wherein jaw members 110 and 120 are closed and cooperate to grasp tissue therebetween. As discussed in more detail below, the end effector assembly 100 may be adapted for use with various energy sources. The jaw members 110 and

120 provide predefined closure force, which is useful to initially coapt the tissue and then in conjunction with the application of energy to permanently fuse the tissue.

**[0014]** The shaft 12 houses a pushrod 101 that is operatively coupled to the movable handle 62 such that when the handle 62 is moved relative to the handle 72 the pushrod 101 moves longitudinally, either proximally or distally within the shaft 12. The pushrod 101 includes a push pin 103 disposed at the distal end 16 of shaft 12. Each of the jaw members 110 and 120 includes a slot 105 and 107, respectively, disposed at the proximal ends thereof. The slots 105 and 107 are in mechanical cooperation with the push pin 103, which is adapted to move within the slots 105 and 107. The pin 103 and slots 105 and 107 operate as a cam-follower mechanical linkage. Motion of the pushrod 101 causes the pin 103 to slide within respective slots 105 and 107. The slots 105 and 107 may be angled with respect to the distal ends of the jaws members 110 and 120 such that the members 110 and 120 move either toward or away from each other as the pushrod 101 is moved longitudinally in a proximal or distal direction, respectively. In other embodiments, the actuating function of the pushrod 101 may be duplicate by a pullrod, a wire, concentrically disposed tubes and other mechanical linkages.

**[0015]** The forceps 10 also includes a trigger assembly 70 that advances a knife 200 disposed within the end effector assembly 100. Once a tissue seal is formed, the user activates the trigger assembly 70 to separate the tissue along the tissue seal. Knife 200 includes a sharpened edge 205 for severing the tissue held between the jaw members 110 and 120 at the tissue sealing site.

**[0016]** The forceps 10 further includes one or more switches 63a and 63b in communication with the generator 20 to enable and/or control the flow of energy to the end effector assembly 100. In one embodiment, the switch 63a activates flow of energy to the end effector assembly 100 and the switch 63b provides for selective energization of elements (if multiple elements/transducers are being used) as discussed in more detail below with respect to Figs. 8 and 9.

**[0017]** With reference to Fig. 3, each jaw member 110 and 120 includes a sealing surface 112 and 122, respectively, disposed on an inner-facing surface thereof. Sealing surfaces 112 and 122 cooperate to seal tissue held therebetween upon the application of energy. Sealing surfaces 112 and 122 are connected to generator 20 that communicates energy through the tissue held therebetween. In particular, one or both of the jaw members 110 and 120 includes an ultrasound transducer 300 disposed on the sealing surface 112 and/or the sealing surface 122. The transducer 300 is connected via a pair of leads 301 to the generator 20 which is adapted to provide an electric signal to induce vibrations in the transducer 300. The transducer 300 may be formed from lead zirconate titanate ("PZT") or any other type of suitable ceramic perovskite material having piezoelectric properties. In another embodiment, the transducer 300 may be formed

from polyvinylidene fluoride ("PVDF") or any other type of suitable polymer. The PZT provides for high heat capabilities, whereas the PVDF has lower heat capabilities than PZT, requiring low duty cycle and/or increased cooling. However, the PVDF provides higher frequency capability, which results in higher absorption rates by the tissue.

**[0018]** During operation, once tissue is grasped between the sealing surfaces 112 and 122, the transducer 300 is energized. This causes rapid ultrasound vibration of the transducer 300 against the tissue, which heats the tissue to a predetermined temperature and seals the tissue under applied pressure of the jaw members 110 and 120.

**[0019]** Each of the jaw members 110 and 120 may include a cooling cavity 310 disposed behind the transducer 300. The cooling cavity 310 is coupled to one or more inflow tubes 311a and one or more outflow tubes 311b. A coolant fluid (e.g., water, saline, silicone, etc.) or gas may be supplied to the cooling cavity 310 to remove heat generated by the vibration of the transducer 300. The gas may be a low mass gas such as helium. The coolant is supplied through the inflow tube 311 a and is withdrawn through the outflow tube 311 b, thereby circulating the coolant through the cavity 310. In one embodiment, the cavity 310 may simply act as an air-backing without any circulation of the coolant therethrough. In addition, the cavity 310 in combination with the coolant fluid and/or gas also reflects the ultrasound energy downward between the jaw members 110 and 120.

**[0020]** In one embodiment, the end effector 100 also includes a temperature sensor 320 disposed on the surface of the transducer 300. The temperature sensor 320 may be a thermocouple probe having two thermocouple wires 321 (e.g., dedicated thermocouple junction wire from about 0.001" to about 0.002") twisted together and soldered together at a junction 322. The temperature sensor 320 may provide temperature feedback to the generator 20, which may then adjust the power delivered to the transducer 300 in response to the temperature readings.

**[0021]** In addition to temperature feedback, the transducer 300 of the tissue sealing system 2 may also be configured to interrogate tissue to determine various tissue properties. In one embodiment, the generator 20 energizes the transducer 300 to produce an ultrasound interrogation pulse (e.g., A-mode ultrasound). The interrogation pulse may be transmitted periodically during the procedure or at any point prior to or after the commencement thereof to determine the thickness or type of tissue being grasped between the jaw members 110 and 120. The interrogation pulse may be of different frequency and amplitude than the treatment pulses used to seal tissue, therefore, supply of treatment pulses may be interrupted to transmit the interrogation pulse. More specifically, the interrogation pulse is transmitted to an interrogation transducer 313 disposed on one of the sealing surfaces 112 or 122, through the tissue and the echo of the pulse

is then captured by the same transducer 313 or other feedback device or sensor (Fig. 3).

**[0022]** In one embodiment, where each of the jaw members 110 and 120 includes a transducer 300, the pulse may be measured as the pulse travels from one of the jaw members 110 and 120 to the other. The echo of the interrogation pulse is then transmitted to the generator 20 through a sense wire 325. Based on the transmission time of the interrogation pulse through the tissue, the generator 20 determines thickness, type, state of the tissue and/or quality of the tissue seal. The generator 20 also determines the completion of the sealing procedure based on the thickness, (e.g., based on the difference between pre-treatment and post-treatment tissue thickness or echogenicity).

**[0023]** Figs. 4-7 illustrate multiple forms of the transducer 300. Figs. 4 and 5 show a transducers 400 and 500 having planar tissue sealing surfaces 402 and 502, respectively. Transducer 400 and 500 are not according to the invention. Figs. 6 and 7 illustrate transducers 600 and 700, which are transducers according to the invention, having a concave tissue sealing surfaces 602 and 702. The concave tissue sealing surfaces 602 and 702 have a curvilinear cross-section that define an inward curvature, which focuses the ultrasound energy toward the center of the sealing surfaces 602 and 702.

**[0024]** With reference to Figs. 4 and 6, the transducers 400 and 600 include longitudinally-oriented channels 404 and 604, respectively, partially cut along a length of the transducers 400 and 600. The channels 404 and 604 extend from the proximal end to the distal end of the transducers 400 and 600. The channels 404 and 604 facilitate longitudinal reciprocation of the knife 200 along a particular cutting plane to effectively and accurately separate the tissue along a formed tissue seal.

**[0025]** With reference to Figs. 5 and 7, the transducers 500 and 700 include longitudinally-oriented grooves 504 and 704, respectively, partially cut along a length of the transducers 500 and 700. The grooves 504 and 704 extend from the proximal end to the distal end of the transducers 500 and 700. The grooves 504 and 704 may also facilitate longitudinal reciprocation of the knife 200 along a particular cutting plane to effectively and accurately separate the tissue along a formed tissue seal.

**[0026]** Figs. 8 and 9 illustrate various embodiments of the jaw members 110 and 120 having two or more transducers 300 disposed on one or both of the sealing surfaces 112 and 122. The transducers 300 may be any of the transducers 600 and 700 discussed above with respect to Figs. 6-7 and may be mounted in parallel or otherwise along the length of the respective jaw members 110 and 120. In Fig. 8, the transducers 300 are arranged longitudinally in parallel relative to each other, in pairs along each side of the sealing surfaces 112 and 122. In Fig. 9, the transducers 300 are disposed along the perimeter of the sealing surfaces 112 and 122.

**[0027]** Each of the transducers 300 may extend to the edge of the sealing surfaces 112 and 122. The transduc-

ers 300 may also be inset to decrease tissue heating at the edge of the sealing surfaces 112 and 122. The edge of the sealing surfaces 112 and 122 may be curved to reduce mechanical strain. The combination of reducing energy flux at the corners of the sealing surfaces 112 and 122 via curvature prevents damage to sealed tissue along the edge of the jaw members 110 and 120. In addition, extending the transducers 300 to the edge of the sealing surfaces 112 and 122 in combination with the selectively applied energy flux provides for a way to divide and/or cut sealed tissue as discussed in more detail below.

**[0028]** Each of the transducers 300 may be configured in a phased array for independent, simultaneous or dependent control (e.g., server-follower control). The array may include any number of transducers 300 (e.g., four) as shown in Fig. 8. In one embodiment, the array of the transducers 300 may be used to change the focus of the ultrasonic energy being applied to the tissue. More specifically, some of the transducers 300 may be activated at one frequency and a second set of transducers 300 may be activated at the same frequency offset by a desired phase angle  $\theta$  causing the ultrasonic energy to spread in a manner suitable for sealing tissue. In another embodiment, the offset phase angle  $\theta$  may be adjusted to deliver other tissue effects (e.g., cutting the tissue).

**[0029]** The switches 63a and 63b may be configured to activate the transducers 300 in a selective manner. In one embodiment, actuation of the switch 63a activates only some of the transducers 300, whereas actuation of the switch 63b activates the remaining set of the transducers 300. In another embodiment, the switches 63a and 63b may be configured to modify the phase angle  $\theta$ . Actuating the switch 63a delivers energy at a frequency offset by a first angle  $\theta$  suitable for sealing tissue, whereas actuating the switch 63b delivers energy at a frequency offset by a second angle  $\theta$  suitable for cutting tissue.

**[0030]** The jaw members 110 and 120 may also include a longitudinally-oriented channel 211 defined in the sealing surface 112 extending from the proximal end to the distal end thereof. The channel 211 facilitates longitudinal reciprocation of the knife 200 along a particular cutting plane to effectively and accurately separate the tissue along a formed tissue seal. The channel 211 may also be defined in the sealing surface 122 or solely disposed in only one sealing surface, e.g., sealing surface 112.

**[0031]** With reference to Fig. 10, another embodiment of the end effector assembly 100 is illustrated. The transducer 300, which may be any of the transducers 600 and 700 discussed above with respect to Figs. 6-7, is disposed on one of the jaws, namely the jaw member 110. The jaw member 120 includes an acoustic reflector 323 for reflecting the ultrasound energy transmitted by the transducer 300 back into the tissue grasped between the jaw members 110 and 120. In addition to the cooling cavities 310, one or both of the sealing surfaces 112 and 122 may include a coupling member 327 disposed over the transducer 300 and/or the acoustic reflector 323. The

coupling member 327 may be an expandable member (e.g., balloon) to be filled with a coolant fluid (e.g., water, saline, etc.) to remove heat generated by the vibration of the transducer 300. The coolant is supplied through the inflow tube (not explicitly shown) and is withdrawn through the outflow tube (not explicitly shown), thereby circulating the coolant through the coupling member 327. In another embodiment, the coupling member 327 may be formed from a coupling gel.

**[0032]** While several embodiments of the disclosure have been shown in the drawings and/or discussed herein, it is not intended that the disclosure be limited thereto, as it is intended that the disclosure be as broad in scope as the art will allow and that the specification be read likewise. Therefore, the above description should not be construed as limiting, but merely as exemplifications of particular embodiments. Those skilled in the art will envision other modifications within the scope of the claims appended hereto.

## Claims

1. An ultrasound forceps (101) for sealing tissue, comprising:

at least one shaft member (12) having an end effector assembly (100) disposed at a distal end thereof, the end effector assembly including opposing jaw members (110, 112) movable from a first position in spaced relation relative to one another to at least one subsequent position wherein the jaw members cooperate to grasp tissue therebetween, at least one of the jaw members includes an ultrasound transducer (600, 700) coupled to an ultrasound generator (20) adapted to provide an electrical signal to the ultrasound transducer to induce at least one treatment pulse therein,

wherein the ultrasound transducer includes a concave tissue sealing surface (602, 702), and **characterised in that:**

the ultrasound transducer includes a longitudinally-oriented channel (604) or groove (704) defined along a length thereof, the longitudinally-oriented channel configured to reciprocate a cutting mechanism therealong.

2. The ultrasound forceps according to claim 1, where the ultrasound transducer is made from lead zirconate titanate.
3. The ultrasound forceps according to claim 1 or 2, further comprising:

a handle assembly (75) including a first handle

(62) and a second handle (72), wherein the first handle is movable relative to the second handle; and

a pushrod (101) operatively coupled at one end to the handle assembly and to the end effector assembly, wherein longitudinal movement of the pushrod moves the jaw members from the first position to the at least one subsequent position.

4. The ultrasound forceps according to claim 1, 2 or 3, further comprising:

a knife channel (211) defined along a length of at least one of the jaw members, the knife channel configured to reciprocate a cutting mechanism (200) therealong; and

an actuator (70) operatively connected to the shaft member for selectively advancing the cutting mechanism from a first position wherein the cutting mechanism is disposed proximal to tissue held between the jaw members to at least one subsequent position wherein the cutting mechanism is disposed distal to tissue held between the jaw members.

5. The ultrasound forceps according to any one of the preceding claims, wherein the ultrasound transducer includes a temperature sensor (320), which is coupled to the ultrasound generator and is adapted to provide temperature feedback thereto.
6. The ultrasound forceps according to any one of the preceding claims, wherein the ultrasound generator is adapted to energize the ultrasound transducer to produce an ultrasound interrogation pulse that is of different frequency and amplitude from the at least one treatment pulse.
7. An ultrasound forceps according to claim 1, wherein each of the jaw members includes a plurality of ultrasound transducers coupled to an ultrasound generator adapted to provide an electrical signal to the plurality of ultrasound transducers to induce at least one treatment pulse therein.
8. The ultrasound forceps according to claim 7, wherein the plurality of ultrasound transducers are controlled in at least one of independent, simultaneous or dependent manner.
9. The ultrasound forceps according to claim 8, wherein the plurality of ultrasound transducers are controlled in a server-follower manner.
10. The ultrasound forceps according to claim 1, wherein the concave tissue sealing surface has a curvilinear cross-section that defines an inward curvature, which focuses ultrasound energy towards the curve

of the sealing surface.

### Patentansprüche

1. Ultraschallzange (101) zum Versiegeln von Gewebe, mit:

mindestens einem Schaftelement (12), das an seinem distalen Ende einen Endeffektoraufbau (100) aufweist, wobei der Endeffektoraufbau sich gegenüberliegende Backenelemente (110, 112) aufweist, die von einer ersten Position in einer relativ zueinander beabstandeten Beziehung zu mindestens einer nachfolgenden Position, bei der die Backenelemente zusammenwirken, um zwischen sich Gewebe zu greifen, bewegbar sind, wobei mindestens eines der Backenelemente einen Ultraschallwandler (600, 700) aufweist, der mit einem Ultraschallgenerator (20) verbunden ist, der angepasst ist, dem Ultraschallwandler ein elektrisches Signal bereitzustellen, um in ihm zumindest einen Behandlungsimpuls zu induzieren, wobei der Ultraschallwandler eine konkave Gewebeversiegelungsfläche (602, 702) aufweist, **dadurch gekennzeichnet, dass:**

der Ultraschallwandler einen entlang seiner Länge in Längsrichtung ausgerichteten Kanal (604) oder Nut (704) aufweist, wobei der in der Längsrichtung ausgerichtete Kanal eingerichtet ist, um an sich entlang einen Schneidmechanismus hin und her zu bewegen.

2. Ultraschallzange nach Anspruch 1, bei der der Ultraschallwandler aus Bleizirkonattitanat hergestellt ist.

3. Ultraschallzange nach Anspruch 1 oder 2, des Weiteren mit:

einer Griffanordnung (75), die einen ersten Griff (62) und einen zweiten Griff (72) aufweist, wobei der erste Griff relativ zu dem zweiten Griff bewegbar ist; und einem Schubstab (101), der betriebsfähig an einem Ende mit der Griffanordnung und mit dem Endeffektoraufbau gekoppelt ist, wobei eine Längsbewegung des Schubstabs die Backenelemente von der ersten Position zu der mindestens einen nachfolgenden Position bewegt.

4. Ultraschallzange nach Anspruch 1, 2 oder 3, des Weiteren mit:

einem Messerkanal (211), der entlang einer

Länge von mindestens einem der Backenelemente definiert ist, wobei der Messerkanal eingerichtet ist an sich entlang einen Schneidmechanismus (200) hin und her zu bewegen; und einem Aktuator (70), der zum gezielten Vorschieben des Schneidmechanismus von einer ersten Position, bei der der Schneidmechanismus proximal zu dem zwischen den Backenelementen gehaltenen Gewebe angeordnet ist, zu mindestens einer nachfolgenden Position, bei der der Schneidmechanismus distal zu dem zwischen den Backenelementen gehaltenen Gewebe angeordnet ist, betriebsfähig mit dem Schaftelement verbunden ist.

5. Ultraschallzange nach einem der vorstehenden Ansprüche, bei der der Ultraschallwandler einen Temperatursensor (320) aufweist, der mit dem Ultraschallgenerator verbunden ist und angepasst ist, ihm ein Temperaturfeedback bereitzustellen.
6. Ultraschallzange nach einem der vorstehenden Ansprüche, bei der der Ultraschallgenerator angepasst ist, dem Ultraschallwandler Energie zuzuführen, um einen Ultraschallabfrageimpuls zu erzeugen, der sich in Frequenz und Amplitude von dem mindestens einen Behandlungsimpuls unterscheidet.
7. Ultraschallzange nach Anspruch 1, bei der jedes der Backenelemente eine Vielzahl von Ultraschallwandlern aufweist, die mit einem Ultraschallgenerator verbunden sind, der angepasst ist, der Vielzahl von Ultraschallwandlern ein elektrisches Signal bereitzustellen, um darin mindestens einen Behandlungsimpuls zu induzieren.
8. Ultraschallzange nach Anspruch 7, bei der die Vielzahl von Ultraschallwandlern in unabhängiger, simultaner und/oder abhängiger Weise gesteuert werden.
9. Ultraschallzange nach Anspruch 8, bei der die Vielzahl von Ultraschallwandlern in einer Server-Follower Weise gesteuert werden.
10. Ultraschallzange nach Anspruch 1, bei der die konkave Gewebeversiegelungsfläche einen kurvenförmigen Querschnitt aufweist, der eine Krümmung nach innen definiert, die Ultraschallenergie in Richtung der Krümmung der Versiegelungsfläche fokussiert.

#### Revendications

1. Pince à ultrasons (101) pour l'étanchéité des tissus, comprenant :

au moins un élément de tige (12) ayant un ensemble formant effecteur terminal (100) disposé au niveau de son extrémité distale, l'ensemble formant effecteur terminal comprenant des éléments de mâchoire opposés (110, 112) mobiles depuis une première position en relation espacée l'un par rapport à l'autre jusqu'à au moins une position suivante dans laquelle les éléments de mâchoire coopèrent pour saisir les tissus entre eux, au moins l'un des éléments de mâchoire comprend un transducteur à ultrasons (600, 700) couplé à un générateur d'ultrasons (20) adapté pour fournir un signal électrique au transducteur à ultrasons afin d'induire au moins une impulsion de traitement, dans laquelle le transducteur à ultrasons comprend une surface d'étanchéité de tissu concave (602, 702), et

**caractérisée en ce que :**

le transducteur à ultrasons comprend un canal orienté longitudinalement (604) ou une rainure (704) définie le long de sa longueur, le canal orienté longitudinalement étant configuré pour faire effectuer un mouvement de va-et-vient à un mécanisme de coupe le long de ce dernier.

2. Pince à ultrasons selon la revendication 1, dans laquelle le transducteur à ultrasons est réalisé à partir de titanate de zirconate de plomb.
3. Pince à ultrasons selon la revendication 1 ou 2, comprenant en outre :

un ensemble de poignées (75) comprenant une première poignée (62) et une seconde poignée (72), dans laquelle la première poignée est mobile par rapport à la seconde poignée ; et une tige de poussée (101) couplée de manière opérationnelle au niveau d'une extrémité à l'ensemble de poignée et à l'ensemble formant effecteur terminal, dans laquelle le mouvement longitudinal de la tige de poussée déplace les éléments de mâchoire de la première position à au moins une position suivante.

4. Pince à ultrasons selon la revendication 1, 2 ou 3, comprenant en outre :

un canal de lame (211) défini le long d'une longueur d'au moins l'un des éléments de mâchoire, le canal de lame étant configuré pour faire effectuer un mouvement de va-et-vient à un mécanisme de coupe (200) le long de ce dernier ; et un actionneur (70) raccordé de manière opérationnelle à l'élément de tige pour faire avancer sélectivement le mécanisme de coupe d'une

- première position dans laquelle le mécanisme de coupe est disposé à proximité du tissu maintenu entre les éléments de mâchoire jusqu'à au moins une position suivante dans laquelle le mécanisme de coupe est disposé à distance du tissu maintenu entre les éléments de mâchoire. 5
5. Pince à ultrasons selon l'une quelconque des revendications précédentes, dans laquelle le transducteur à ultrasons comprend un capteur de température (320), qui est couplé au générateur d'ultrasons et est adapté pour fournir une rétroaction de température à ce dernier. 10
6. Pince à ultrasons selon l'une quelconque des revendications précédentes, dans laquelle le générateur d'ultrasons est adapté pour alimenter le transducteur à ultrasons afin de produire une impulsion d'interrogation à ultrasons qui est d'une fréquence et d'une amplitude différentes de la au moins une impulsion de traitement. 15  
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7. Pince à ultrasons selon la revendication 1, dans laquelle chacun des éléments de mâchoire comprend une pluralité de transducteurs à ultrasons couplés à un générateur d'ultrasons adapté pour fournir un signal électrique à la pluralité de transducteurs à ultrasons afin d'induire au moins une impulsion de traitement dans ces derniers. 25  
30
8. Pince à ultrasons selon la revendication 7, dans laquelle la pluralité de transducteurs à ultrasons sont commandés d'au moins une manière parmi une manière indépendante, une manière simultanée ou une manière dépendante. 35
9. Pince à ultrasons selon la revendication 8, dans laquelle la pluralité de transducteurs à ultrasons sont commandés avec un serveur. 40
10. Pince à ultrasons selon la revendication 1, dans laquelle la surface d'étanchéité de tissu concave a une section transversale curviligne qui définit une courbure vers l'intérieur qui concentre l'énergie ultrasonore vers la courbe de la surface d'étanchéité. 45

50

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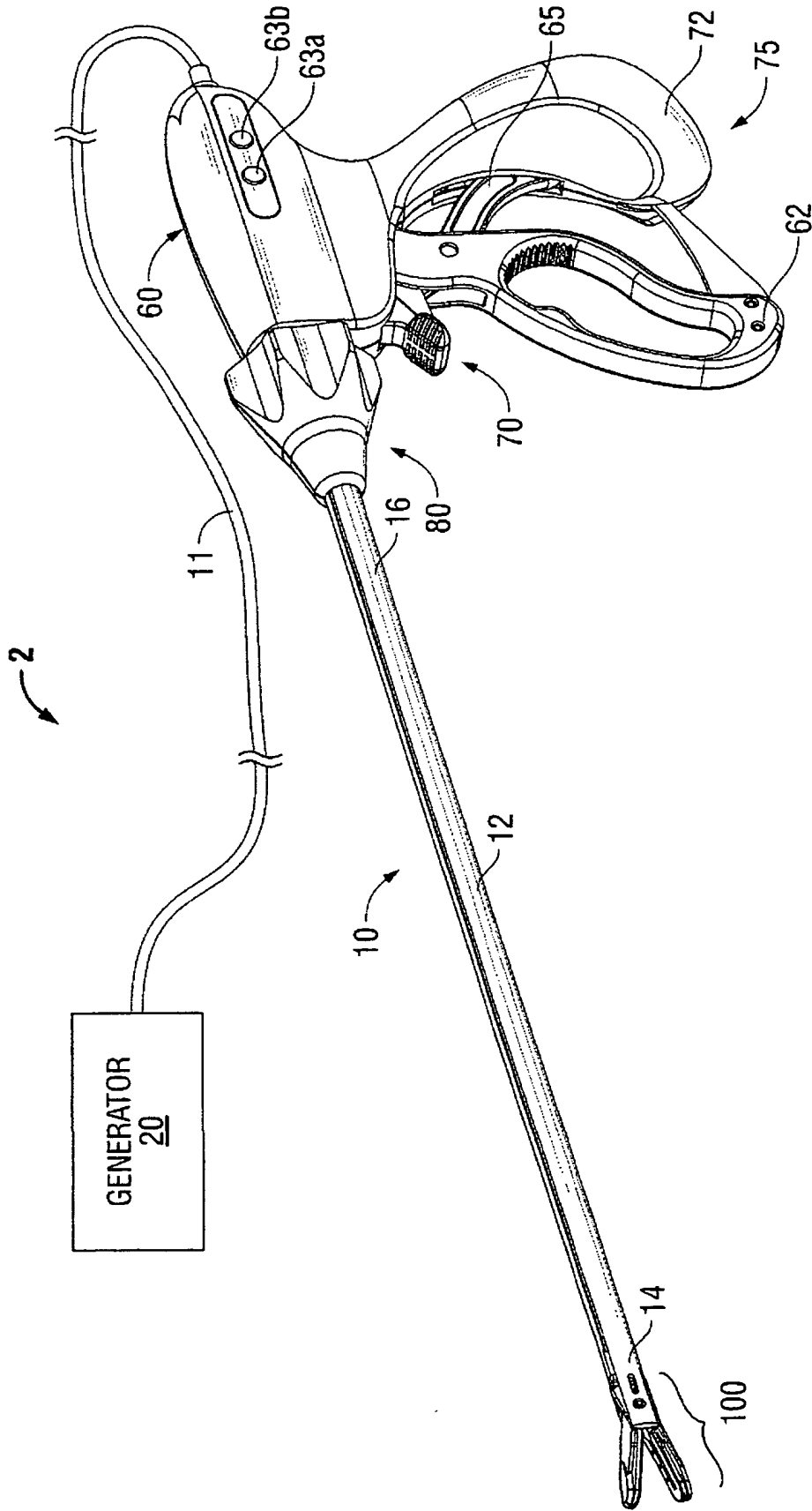


FIG. 1

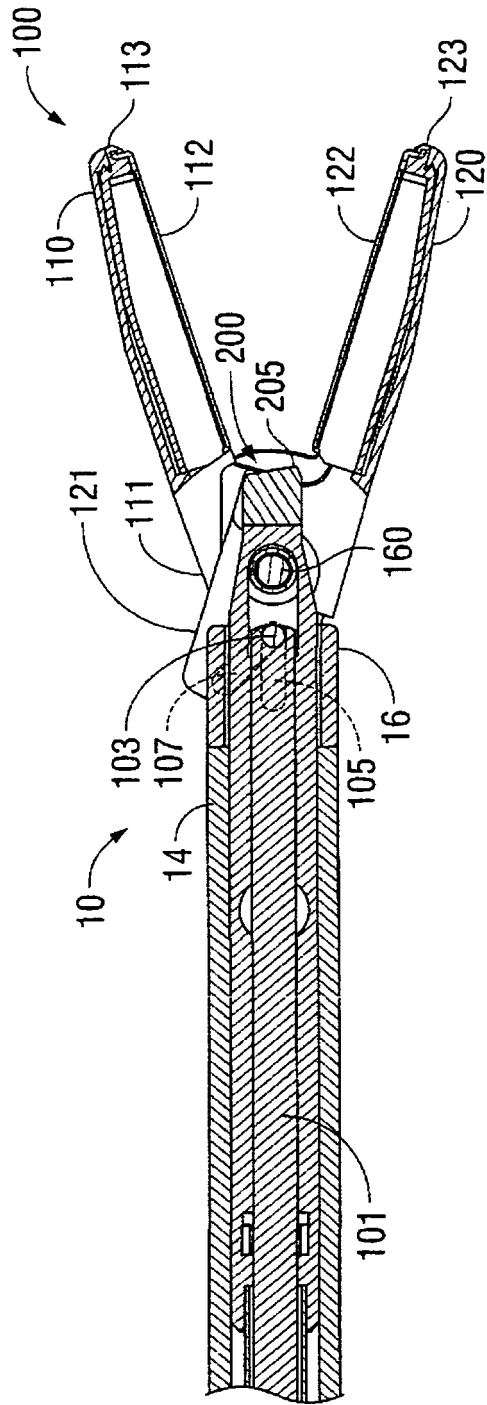


FIG. 2

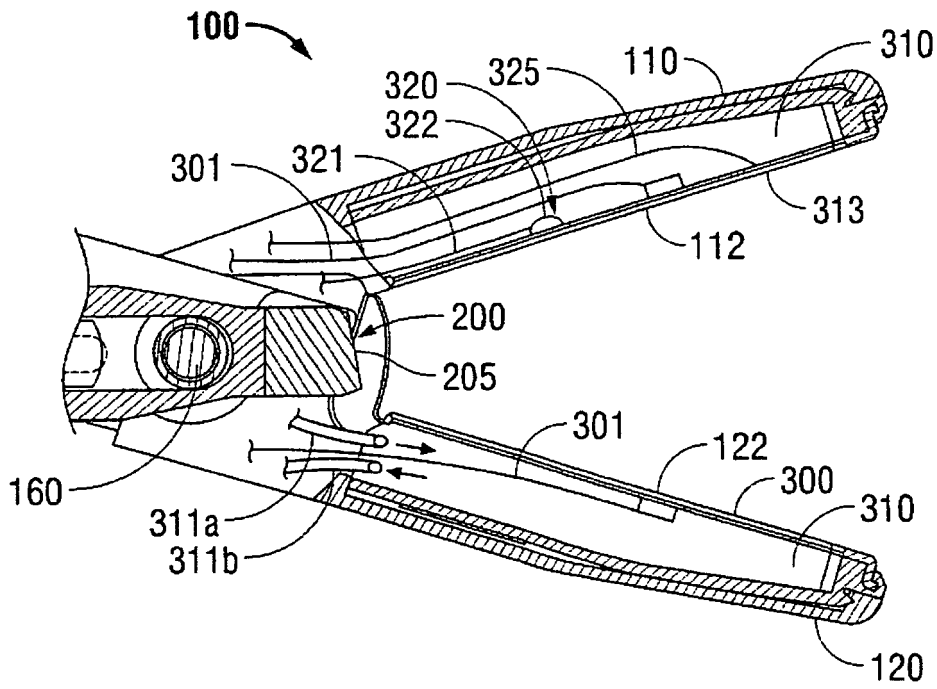


FIG. 3

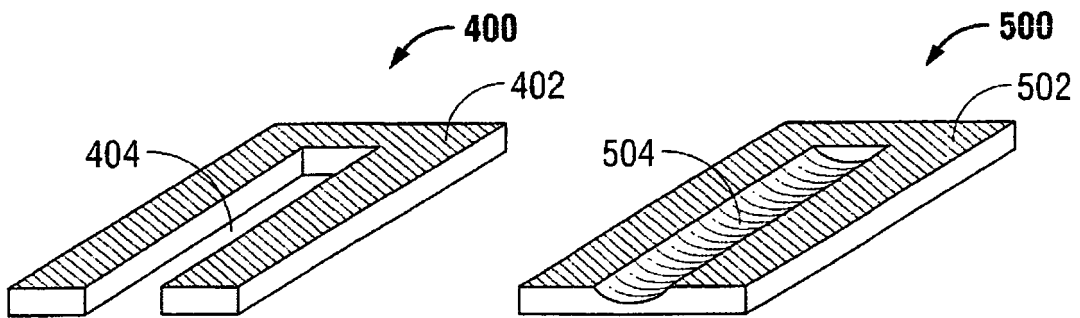
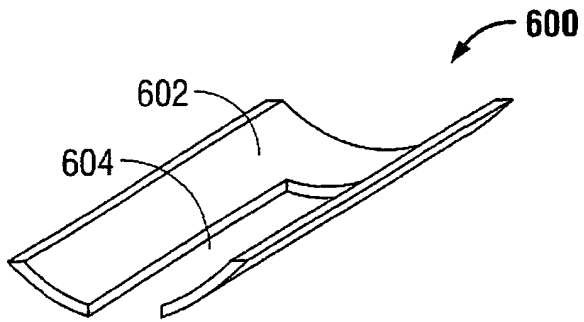
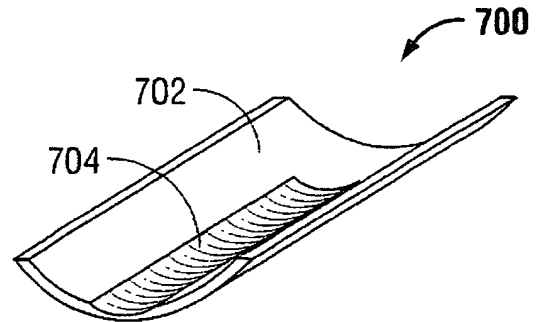


FIG. 4

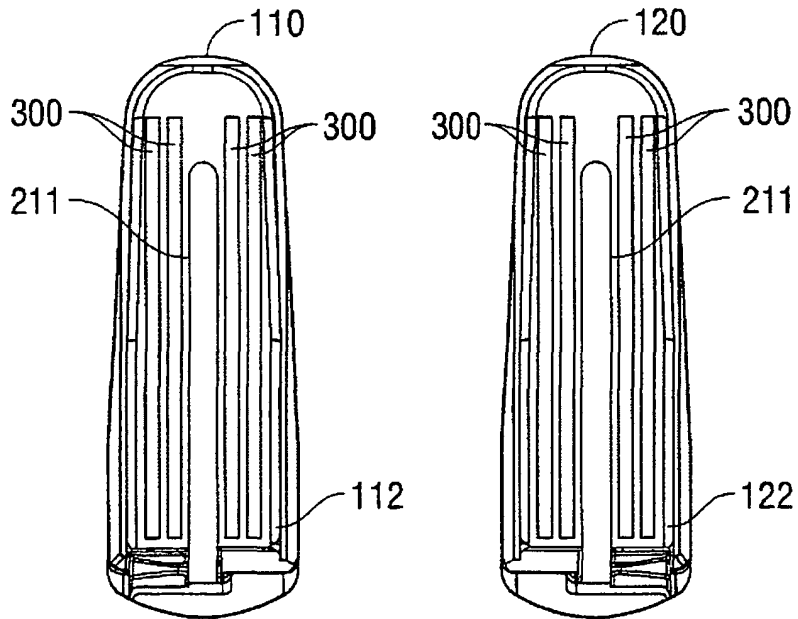
FIG. 5



**FIG. 6**



**FIG. 7**



**FIG. 8**

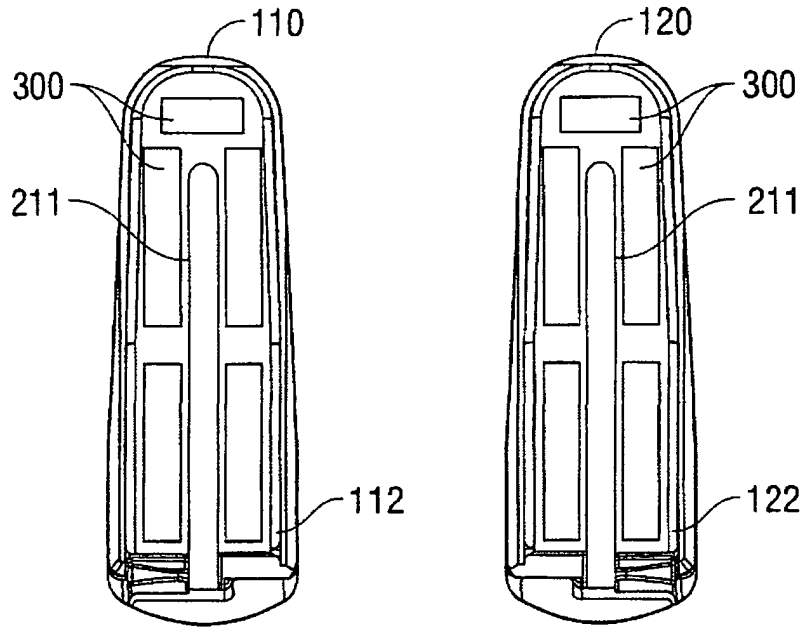


FIG. 9

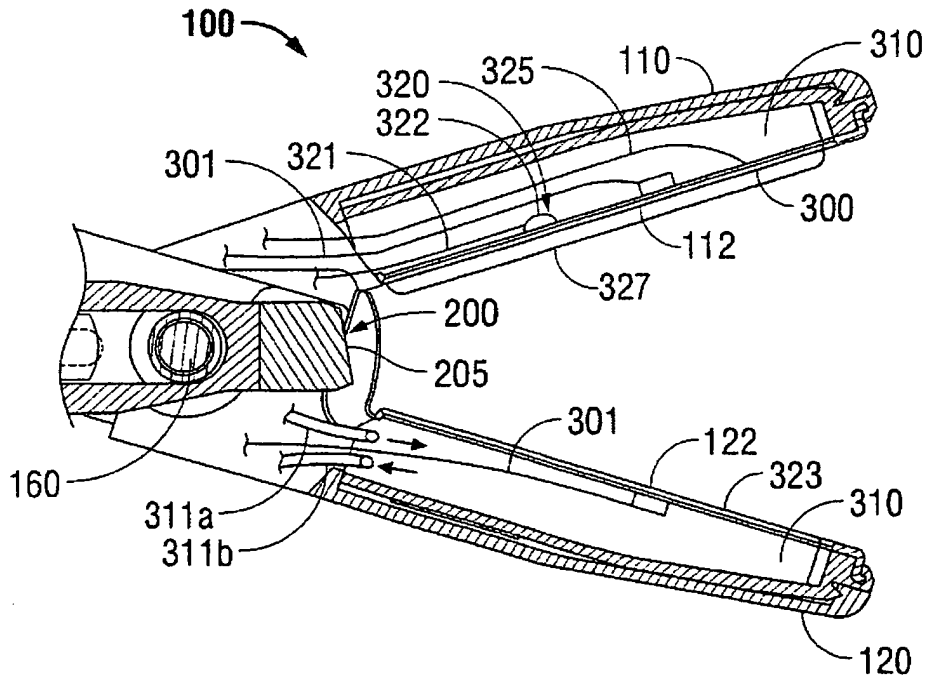


FIG. 10

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

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